Connecting optical theory to practical applications FREE

Imaging Optics. , Joseph Braat and Peter Török, Cambridge U. Press, 2019, $99.99 Buy on Amazon

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tions to astronomical observations that changed our views of the heavens and the challenges they faced chasing solar eclipses to prove the theory of general relativity. Mary's persistence and self-direction in teaching herself about astronomy was also well described.

If you can read *Dante and the Early Astronomer* as a work of creative history, then you may gain some insight into the life of Mary Orr Evershed. The bibliography is extensive, and I surmise that readers can learn more about Mary from the historical primary sources. However, as a stand-alone read, the title's promise of "science" from a "woman who opened the heavens" goes unfulfilled.

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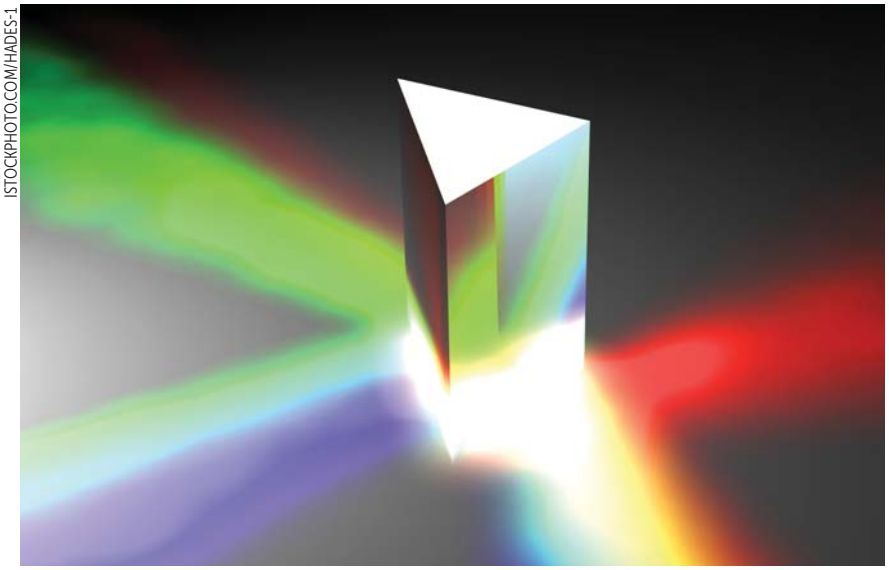

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Connecting optical theory to practical applications

My first reaction upon receiving a copy of *Imaging Optics* by Joseph Braat and Peter Török could have been, "Do we really need a new book on optical imaging?" But after reading their work, I am convinced that we do. *Imaging Optics* brilliantly complements an already well-supplied field that includes such classics as *Principles of Optics* by Max Born and Emil Wolf (7th edition, 1999).

Imaging Optics establishes a clear connection among the electrodynamic theory of optical propagation, the various approaches to diffraction theory, and the practical methods used in the design and optimization of imaging systems. The book's way of linking those topics is original, as is the way the text moves from the conceptual aspects of optics to immediately usable practical results. The ability to transition smoothly between theoretical foundations and practical methods is one of the book's best features. Examples include the transition from Maxwell's equations to geometrical optics and lens design and the combined use of vector diffraction and coherence theories to describe recent imaging approaches that utilize light polarization. The depth of the content and great coherence in the presentation reflect the extensive teaching experience of both authors. In addition, each of the book's three parts begins with a historical discussion that provides illuminating context for their topics.

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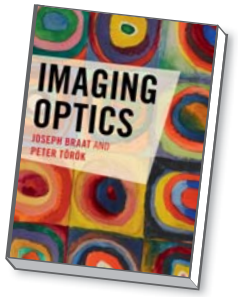

Part 1, "Electromagnetic Theory in the Optical Domain," covers the propagation of electromagnetic waves in isotropic media. Readers will appreciate the comprehensive treatment of Gaussian beams. The section also covers multilayer and periodic geometries and a useful introduction to specific numerical methods. The authors devote a full chapter to propagation in anisotropic media, with a clear discussion of conical diffraction. My only concern is the treatment of material dispersion, a topic overlooked in the first two chapters. The issue of dispersion is only addressed in chapter 3 with the introduction of metamaterials. That chapter also offers an interesting introduction to the concept and limitations of a perfect lens.

In part 2, "Geometrical Theory of Optical Imaging," Braat and Török start with a derivation of the laws of geometrical optics from first principles and then move on to introduce the concept of a characteristic function and its use in practical situations. The next chapter presents an analysis of aberration in the framework of geometrical optics, including a clear classification of the different types of aberrations and a detailed calculation of the Seidel aberration coefficients. The section finishes with two chapters that describe imaging systems and examine their optimization. Those chapters will be very useful to readers concerned with learning the basic methods for designing components and imaging systems.

Part 3, "Diffraction Theory of Optical Imaging," reviews the theory of diffraction and its applications, from the complete vector to the scalar theory. The section's ultimate goal is to characterize imaging systems beyond geometrical optics. Here formal theories are smoothly connected to practical methods that are illustrated with real examples, such as scanning confocal microscopy and the imaging of fluorescent molecules embedded in a multilayer structure. I thought the in-depth treatment of the subtle problem of calculating the fields in the focal region was a strong point in this section, and I also appreciated the discussion of the relationships between the different theoretical approaches to diffraction.

The authors then cover diffraction in the presence of aberrations, including a detailed presentation of the Nijboer–Zernike theory, and give an analysis of imaging systems in terms of a transfer function. Part 3 ends with a chapter on vector imaging that uses polarization degrees of freedom. The beautiful explanation of the underlying theory merges concepts and methods from diffraction and partial coherence theories. The chapter gives readers a glimpse into an active field in optical imaging research. I suffered one little frustration: Scanning near-field optical imaging was omitted, which is unfortunate since it is an interesting technique both conceptually and because of its broad range of applications.

Imaging Optics contains a high level of technical detail, but its content can be approached at different levels, from conceptual to technical and applied. The authors' success at creating a complete, precise, and pedagogically effective text should make *Imaging Optics* not only a good choice for students, but also a useful reference book for physicists and engineers interested in the design, development, and optimization of optical imaging systems.

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